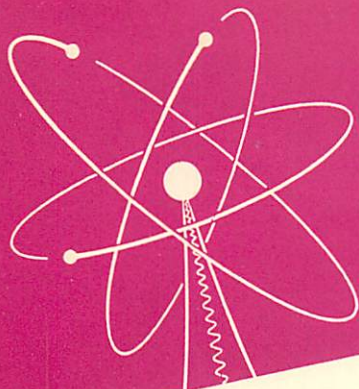
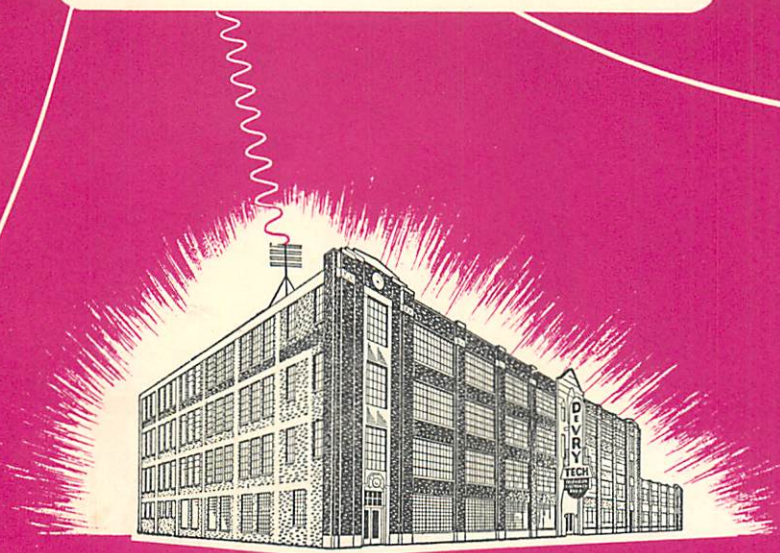




TV RECEIVER ALIGNMENT

Lesson T4E-1A



DeVRY Technical Institute

4141 W. Belmont Ave., Chicago 41, Illinois

Formerly DeFOREST'S TRAINING, INC.

TV RECEIVER ALIGNMENT

4141 Belmont Ave.



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To obtain a clear and distinct picture on the screen and faithful reproduction of sound, proper alignment of all the tuned circuits in a television receiver is necessary.

Courtesy Stewart Warner Corp.

TV RECEIVER ALIGNMENT

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Television is a powerful giant of science in need of recruits to swing it into action as a service to the public. The call goes out for captains of industry born with vision. Also for engineers, showmen, merchandisers, actors, scenic designers, scenario writers, producers, cameramen, directors, musicians and thousands of others required to stage such a multi-ringed circus in a medium that conveys sight and sound as fast as they are tossed to the camera and the microphone.

—Selected

TV RECEIVER ALIGNMENT

TELEVISION RECEIVER FREQUENCY RESPONSE

In the r-f section and picture channel of any television receiver, the interstage coupling circuits must be responsive to broad bands of frequencies and, at the same time, provide rejection to frequencies above and below the limits of these desired bands. The usual response of the r-f section is shown by the curve of Figure 1. Here, the response is essentially flat over a band of frequencies 6 mc or more in width as indicated, and is attenuated above and below this band.

However, the curve shows that the r-f circuits are not sharply selective. They pass considerable energy at the frequencies of the lower adjacent channel sound carrier and upper adjacent channel picture carrier. In addition to the undesired carriers, sideband components in the adjacent channels also are passed by the broadly tuned r-f circuits of the receiver. Thus, although contributing to the sensitivity of the receiver, the r-f section provides very little of the necessary selectivity.

The desired selectivity characteristic is obtained in the tuned circuits of the receiver i-f amplifier, as shown by the curve of Figure 2. Here, the pass band is

reduced in width to 4 mc or less, over which essentially uniform response is acquired by sharp attenuation at the ends. This reduction is necessary to reject the intermediate frequencies formed by the oscillator output heterodyning with the various undesired adjacent channel signals passed by the r-f tuning circuits. The frequencies produced by the upper adjacent channel picture carrier, and that due to the lower adjacent channel sound carrier, respectively, are indicated in Figure 2 by broken lines.

In addition, the selectivity must be such that the response to the sound i-f carrier is only about 5 to 10 per cent of maximum to avoid video buzz. Finally, the slope at the high frequency end of the i-f response curve must be such that the response to the picture i-f carrier is about 50 per cent of maximum. This arrangement prevents the low frequency video components from having twice the normal amplitude due to their double-sideband transmission. Because of these exacting response requirements, the receiver i-f amplifier needs adjustment or alignment more frequently than the r-f section.

In general, the curve of Figure 2 represents the response requirements of the i-f amplifier circuits

between the output of the mixer and the input of the video detector in a television receiver, regardless of the type of picture and sound i-f channel arrangement. In addition to these circuits, the dual-channel receivers contain two or more stages of sound i-f amplification in which the tuned circuits have symmetrical response about the sound i-f carrier as shown in Figure 5B. The inter-carrier receivers contain at least one amplifier stage with tuned circuits having similar response for the 4.5 mc second sound i-f carrier frequency. Finally, in both types of receivers, the audio detector stage has the "S Curve" response pictured in Figure 5C, as explained in detection methods.

RECEIVER SECTIONS REQUIRING ALIGNMENT

When a television receiver is assembled at the factory, alignment must be made of every section which contains tuned circuits, including the r-f section, picture i-f section, sound i-f section, and the 4.5 mc traps, if any, in the video section. Included in the picture i-f section, one or more trap circuits also are adjusted at this time.

Once tuned, the r-f section seldom becomes mis-aligned; therefore, most of the later alignment adjustments are confined to those

circuits following the mixer stage. That is, in television receiver servicing, it generally is not necessary to perform a complete re-alignment of the entire receiver, but rather only of the particular section or sections which are out of alignment.

In their service manuals, receiver manufacturers list the alignment instructions for each



This multiple-function instrument provides signal outputs in the frequency range required for television receiver alignment.

Courtesy RCA Victor Div.,
Radio Corporation of America

section separately, although the order in which the sections are listed usually indicates the sequence to be followed when more than one section is to be aligned. In some cases, alignment instructions for the r-f amplifier and mixer or the entire r-f section are omitted from the manual when these circuits are deemed to

be sufficiently stable so realignment is rarely necessary.

Although there is some variation, the most common sequence employed in the receiver alignment is as follows:

1. Picture i-f Section
2. Sound i-f Section
3. R-F Section

In some cases, the service manuals specify that the oscillator should be aligned before the r-f amplifier and mixer, while in other cases the reverse order is suggested.

INDICATIONS OF MIS-ALIGNMENT

In general, mis-alignment of the television receiver tuned circuits results in poor picture quality, poor sound, or both. However, these same symptoms may be caused by other faults, or misadjustments, and checks for these causes should be made before the time consuming alignment procedure is begun.

Examples of faults which cause receiver operation similar to that produced by mis-aligned circuits are: faulty antenna installation, improperly set operating controls, incorrectly positioned ion trap, defective tuner, defective parts or tubes in r-f or i-f stages, defective peaking coils in video detector or amplifier stages, and defective focus coil or picture tube.

All such possible causes of trouble should be checked by means of visual inspection, control adjustments, and the various dynamic and static testing methods described in previous lessons. Only when these checks have been made and all circuit components and voltages found to be satisfactory should alignment be considered necessary to correct the trouble.

The trouble symptoms should be observed carefully in an attempt to determine which section or sections need alignment. For example, either the picture i-f section or the sound i-f section may be mis-aligned if the best reception of both picture and sound cannot be obtained at the same setting of the fine tuning control. An improperly tuned trap circuit may result in interference in either the reproduced picture or sound. The i-f amplifiers must be aligned so they have not only the proper frequency response, but the proper gain as well. The reproduced picture may lack detail, or the balance between the shading in the large areas and the details may be improper if the picture i-f section is mis-aligned with respect to frequency only. However, if the mis-alignment is such that the picture i-f band-pass is wider than necessary, the gain is lowered and a washed-out picture lacking in contrast and susceptible to noise is obtained.

Inability to reduce the video buzz level sufficiently by adjusting the operating controls of an intercarrier receiver may be due to improper alignment in the picture or sound i-f amplifier. However, a defective tube or circuit can give the same results.

Distorted sound is caused by mis-alignment in the sound i-f section, or the discriminator circuit, with respect to the frequency of the sound i-f carrier. If the sound i-f circuits are tuned too broadly, the reduced gain may cause reduced volume in the sound output. On the other hand, too sharp tuning of these circuits may result in distortion due to clipping on signal deviation peaks, and require frequent retuning to bring the sound in.

The receiver high-frequency oscillator may become mis-aligned to the extent that it is impossible to bring in the sound at all by adjusting the fine tuning control, although picture reception is acceptable. This situation is more likely to occur in the dual-channel type receiver, but can exist in an intercarrier receiver as well.

If picture details are poor, or the reproduced sound is weak, or both, the r-f or mixer circuits may be in need of alignment. Note that these symptoms are the same as those which indicate (and are more likely caused by) misalign-

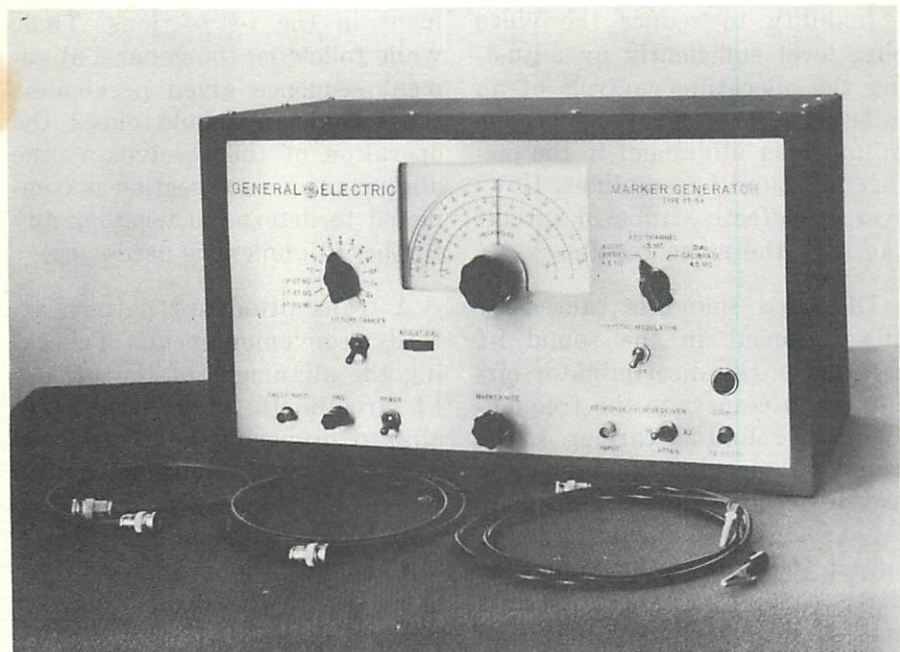
ment in the i-f sections. Thus, while following the general alignment sequence given previously, the technician should check the operation of the receiver as the alignment of each section is completed to determine whether any further alignment is necessary.

A transmitted test pattern affords a convenient means of checking the alignment of the picture i-f circuits. If these circuits are aligned properly, the reproduced pattern should contain vertical wedges which are clear and sharp near the narrow end, and the detail should be in proper contrast balance with the shaded area.

ALIGNMENT EQUIPMENT

The particular instruments needed depend upon the alignment technique used by the serviceman. For those who tune each circuit separately to the resonant frequency listed by the manufacturer, an r-f generator and a voltmeter are needed. Others prefer to adjust the over-all response of the r-f or i-f amplifier by means of a sweep generator and oscilloscope to conform to a desired response curve.

An r-f generator suitable for television receiver alignment should have a tuning range from 4 mc to 50 mc to align the i-f amplifiers, and a range from 50 mc to 220 mc to align the r-f stages



A signal generator designed specifically for producing the various marker signals needed for TV receiver alignment.

Courtesy General Electric Co.

of a VHF receiver. A received signal may be employed for making oscillator adjustments in UHF tuners, although complete tuner alignment usually requires a generator which provides signals over the UHF range of from 470 mc to 890 mc.

The generator should have a continuously variable attenuator to control the output over a range from one microvolt to about one tenth of a volt. In order to duplicate the alignment recommended by the manufacturer, accuracy becomes important. In fact, calibration error in excess

of 2% may cause sufficient circuit mis-alignment to produce poor quality pictures.

To obtain accurate output indications, the voltmeter used for alignment should not load the circuits under test to any great extent. Any voltmeter having a resistance of at least 20,000 ohms per volt is satisfactory, although an electronic type (vtvm) is preferred.

The controls and front panel appearance of a typical sweep generator are illustrated in Figure 3. This particular model is a dual unit in that it consists of a

sweep generator and an r-f signal generator (Marker Oscillator) in the same case. The dial at the upper left of the panel and the large octagonal knob are used to set the sweep generator at the desired center frequency, and the band over which this generator sweeps is determined by the setting of the SWEEP MC control located at the center of the panel.

The center frequency may be chosen in any of the three ranges, 2 to 38 mc, 38 to 88 mc, and 174 to 216 mc for television work, and in the 88 to 108 mc band for FM radio alignment. The sweep width may be varied in steps from 0 to 12 mc. For example, with the SWEEP OSCILLATOR set at 40 mc, and the SWEEP MC switch at 12 mc, the generator sweeps from 34 to 46 mc.

Directly beneath the sweep oscillator dial, the SWEEP switch permits turning the sweep oscillator on and off. The RANGE switch permits selection of one of the operating ranges mentioned, while the LINE SWITCH closes the circuit from the line cord to the power supply of the unit. At the lower left of the panel are the r-f output jack and binding post, and the coarse (MULTIPLIER) and fine (RF OUTPUT) output controls, respectively.

To determine whether the receiver tuned circuits are respon-

sive to the desired band of frequencies, it is common practice to inject an r-f signal of a known frequency along with the sweep signal. This constant frequency input results in a small disturbance, or pip, at the point on the observed curve corresponding to the known frequency. These pips are generally called "markers", and one or several may be employed to check various points on the response curve.

Any ordinary r-f signal generator which operates in the proper ranges may be used as a source of marker signals, and, in the unit of Figure 3, the MARKER OSCILLATOR consists of an r-f generator which provides a signal in any of the television i-f and r-f ranges, depending upon the setting of its RANGE switch.

The ranges available are: 4 to 8 mc, 16 to 29 mc, and 27 to 54 mc on fundamentals, and 8 to 16 mc, 54 to 108 mc, and 108 to 216 mc on harmonics. The marker frequencies are given on the dial at the upper right of the panel, and the internal circuits are arranged to superimpose the marker signal on the sweep signal output. The MARKER OUTPUT control varies the amplitude of the marker signal.

At the jack labeled C.R.O., a 60 cycle sine wave voltage is available for use as the time base for

the oscilloscope. The sweep generator output is swept over its range, from minimum to maximum and back to minimum, 60 times a second, and the PHASE control adjusts the relative sweep and time base phase so that a single trace is obtained on the oscilloscope screen.

At the lower center of the panel, Figure 3, the EXT. MARKER jack permits insertion of a second marker signal from an external signal generator.

The unit contains a circuit which may be operated as an a-f oscillator or as a crystal r-f oscillator as desired. The MOD. switch turns the audio oscillator on, and its 400 cycle signal modulates the r-f output of the marker generator. For this use, the sweep generator is turned off, and the modulated r-f output of the marker is available from the r-f output jack. With a crystal plugged into the socket provided, the oscillator provides a signal of accurate frequency which may be used for a test signal. The crystal oscillator output is available at the r-f output jack. Finally, the MARKER SWITCH turns the marker generator on or off.

The curves of Figure 4 illustrate the various patterns which are obtained on the screen of an oscilloscope when the outputs of different sweep generators are

applied to the picture i-f circuits of a television receiver. If both the sweep generator and the oscilloscope employ a linear or sawtooth sweep, the curve obtained is similar to that of Figure 4A.

However, most sweep generators employ a sine wave sweep, and, if this type of test signal is used with a sawtooth time base in the scope, a double trace pattern like that of Figure 4B is obtained. This pattern is due to the fact that the sweep output varies from a minimum to maximum frequency while the oscilloscope beam moves steadily from left to right on the screen. Then, the beam quickly snaps back to the left side after which it again moves from left to right while the sweep output is changing in frequency from maximum to minimum.

Since the receiver picture i-f circuits are tuned to provide the more gradual drop-off in response near the high frequency end of the pass band, this portion of the curve is produced at the right side of the scope screen for one trace of the beam, and at the left side for the next trace, and so on.

Like the unit of Figure 3, most sweep generators provide a sine wave voltage which can be applied to the oscilloscope horizontal amplifier input and used for the scope time base. With this

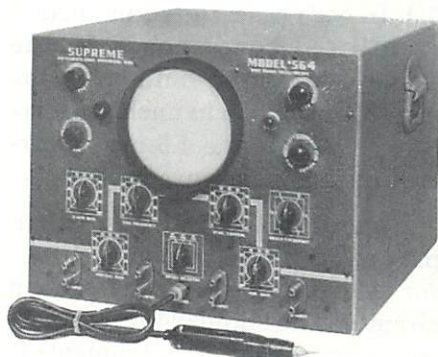
arrangement, the time base and sweep rate coincide and a pattern like that of Figure 4A is obtained. If the sweep generator phase control is not set properly, the forward and return traces do not fall at the same position on the screen, and a double trace pattern like Figure 4C is produced. Note that, in this case, the gradual slopes of both curves are at the same side of the screen.

With the sweep signal blanked during the return trace periods, a horizontal line at zero response level is produced on the scope screen for this trace, and a response curve pattern is produced during the forward trace only, as shown in Figure 4D. Depending upon the sweep generator, oscilloscope, and receiver video detector circuit arrangements, the curves produced may be inverted, turned left-for-right, or both with respect to those illustrated in Figure 4.

Figure 5 illustrates the manner in which the desired response in the various sections of the receiver is specified in the manufacturer's service manuals. The curve of Figure 5A shows the proper over-all response of the picture i-f section. The short vertical lines indicate the points at which the marker pips should be located. If several marker signal sources are available, they all can be applied at the same time. However, a

single marker generator can be set to the various test frequencies in succession, and the response of the circuit at each point checked against the given standard pattern.

The actual check frequencies employed vary with different receiver makes and models, and generally are included to indicate the marker points in diagrams like those of Figure 5. Located at



The r-f probe in front of this wide-range oscilloscope permits observing the response of individual i-f amplifier stages in a TV receiver.

Courtesy Supreme Instrument Corp.

the midpoint of the right hand slope of the curve of Figure 5A, the picture carrier intermediate frequency marker indicates that the over-all response at this frequency should be 50% of maximum.

When the sweep generator method is used to align the sound i-f amplifier circuits, a marker signal at the i-f carrier frequency

is employed. The response should be symmetrical about this frequency as shown by the curve of Figure 5B. Also, as shown in Figure 5C, the FM detector response increases linearly, but in opposite polarity, as the test signal varies each side of the i-f carrier.

When a sawtooth time base is used in the scope, with sine wave frequency variation in the sweep generator, the FM detector response curve appears as shown by the standard pattern of Figure 5D. In each case, the signal marker utilized corresponds to the sound i-f carrier output of the mixer for dual channel type receivers, and to the 4.5 mc i-f carrier in intercarrier receivers.

Figures 5E and 5F are examples of specified response curves for television receiver r-f section circuits. The standard of comparison for oscillator alignment is shown in Figure 5E, where the picture carrier marker is at 50% response on one slope of the curve and the sound carrier marker is near zero response on the other slope. Typical response required in the r-f amplifier and mixer stages is indicated in Figure 5F. Here, the dashed lines show the maximum allowable variations for different units of a given receiver.

ALIGNMENT PREPARATION

Regardless of the procedure practiced in the alignment proper

for any given case, certain preliminary preparations are necessary to permit the actual adjustments to be made with a maximum of convenience, safety, and accuracy.

Since tuning adjustments both above and below the chassis usually are necessary, the receiver chassis must be removed from the cabinet. The chassis should be placed on a bench so that it rests on a side which is free of controls or other protruding parts. To prevent tipping, the chassis should be braced by some means such as blocks arranged so they will not slip away.

For alignment and other service work, it sometimes is desirable to remove the picture tube from the chassis for convenience as well as for personal safety. When this is done, the tube should be kept in a regular picture tube carton until it is time to replace it.

In some cases, the picture tube must remain in the socket during alignment, and therefore must be removed from the cabinet along with the chassis. In the event the tube is not chassis mounted, it may be inserted through the yoke and the focus magnet, and attached to its socket, but to prevent breakage, its weight should be supported by a leather strap or an improvised bracket around

the tube face. THE PICTURE TUBE WEIGHT MUST NOT BE SUPPORTED BY ITS NECK.

In the case of receivers with series connected heaters, removal of the picture tube breaks the continuity of the heater circuit, and a substitute resistive component must be used in place of the picture tube heater. In most cases the heater of a 6SN7GT type tube is suitable for this purpose. All the base pins of the 6SN7GT are clipped off except pins 7 and 8. These heater pins will fit into the picture tube socket openings 1 and 12. The keyway on the 6SN7GT base will not line up with the keyway slot in the picture tube socket, but this does not interfere with the insertion of the tube. Such an arrangement re-establishes continuity in the heater circuit and provides the proper voltage drop across this portion of the circuit. The 6SN7GT used may be an old or defective one, so long as its heater is in good condition.

As a precaution against high-voltage shock, several manufacturers recommend some method of rendering the high-voltage supply circuit inoperative. Usually, this is accomplished by removal of either the horizontal oscillator tube or the horizontal output tube. Again, however, it is emphasized that the specific instructions for each model should be consulted. For example, in the

case of certain Admiral models, the instruction manual states that neither of these tubes should be removed from their sockets during alignment. On the other hand, for the Dumont Models RA-112A and RA-113, removal of the damper tube is directed.



A large dial permits accurate setting of the center frequency of the sweep oscillator in this TV alignment generator.

Courtesy Coastwise Electronics Co., Inc.

To prevent errors due to drift during warm-up, all test equipment to be used for the alignment should be turned on 20 minutes to half an hour in advance. This procedure applies to any test equipment with which fairly accurate measurements are to be made, whether for alignment or otherwise. Therefore, at the beginning of the day when the need for certain instruments such as signal generators is known, it is

a good plan to turn them on the first thing, and leave them on all day when in the service shop. Thus, they are warmed-up and ready for immediate use throughout the day.

PICTURE I-F ALIGNMENT

During alignment of the i-f circuits, erroneous indications may be obtained if signals other than the desired test signals are applied to the input of the section under test. Therefore, some means of preventing the production or passage of signals by the r-f section should be employed. The simplest means consists of removing the oscillator tube in those sets in which this tube is contained in a separate envelope.

In receivers where the mixer and oscillator are in the same envelope, such as the 6J6 duotriode, this tube is removed and a dummy tube inserted in its place. The dummy is made by clipping the base pin corresponding to the oscillator plate from a spare tube of the same type. This arrangement leaves the mixer in operating condition, it being needed as a means of injecting the i-f test signals. A sometimes used method of disabling the oscillator by clipping a capacitor from the oscillator grid to ground should be avoided. Excessive oscillator plate current may damage the series resistor.

To prevent interference from

received signals, the channel selector should be set to a channel in which no station is operating in the area. In some cases, various other control settings are specified by the manufacturer, and should be made accordingly.

The test signal causes variations of the bias in the picture i-f stages due to the action of the receiver agc circuit, and thus results in undesirable changes in stage gain. Usually this fault can be avoided by keeping the signal low. However, to prevent the action, several manufacturers specify the use of a small battery, with its negative terminal connected into the agc circuit and its positive terminal connected to ground. The values required range between -1.5 and -4.5 volts and may be obtained conveniently from a simple bias source consisting of the components shown in the circuit of Figure 6. Potentiometer P_1 has a resistance of 10,000 ohms, and capacitors C_1 and C_2 each have a capacitance of $.05 \mu\text{f}$.

For alignment of the picture i-f section, the test equipment connections most often employed are illustrated in the simplified diagram of Figure 7. For the first part of the alignment, the r-f signal generator or sweep generator output is applied to the receiver mixer stage, and the vtvm or oscilloscope is connected across the video detector load re-

sistor as shown. For the over-all response check and final adjustments, the sweep generator is connected to the antenna terminals, and the oscilloscope is left on the detector load.

The signal (or sweep) generator connections to the mixer input are made by clipping the high side of the generator output cable to a tube shield which fits snugly over the mixer tube. For this use, the shield is not permitted to touch the chassis. The ground side of the cable is connected to the chassis close to the mixer tube base. This arrangement provides capacitive coupling between the floating tube shield and the elements of the mixer tube so that the test signal is injected into the i-f circuits. The coupling can be varied by sliding the shield up and down over the tube.

Another method of injecting the test signal consists of removing the mixer tube and wrapping a short length of bare wire around the mixer grid pin in such a way that the end of the wire projects from under the base when the tube is replaced in its socket. Then the high side of the generator cable is connected to this wire through a .001 to .005 μ f capacitor. Leads should be kept as short as possible, and an alternative method consists of eliminating the length of wire,

and twisting the blocking capacitor lead around the mixer tube grid pin.

In some receivers, the test generator cable can be connected to a mixer circuit injection point through a hole or a test point provided for the purpose in the tuner chassis. Again, a blocking capacitor should be employed, and the ground side of the generator cable is connected to the tuner cover. These connections are illustrated in Figure 8, along with a method of coupling the energy from an external marker generator into the output lead from the sweep generator. The twisted, insulated wires provide sufficient capacitive coupling to superimpose the marker energy onto the sweep signal.

In a few receivers, the video detector load circuit is at a high d-c potential with respect to the receiver chassis. In this case, precaution should be taken to avoid touching or grounding the case of the vtvm or oscilloscope.

In picture i-f section alignment where the test signal is injected at the mixer stage, it is of paramount importance that the TRAPS ARE ALIGNED FIRST. This is true regardless of whether or not there are interfering stations in the area, for a misadjusted trap makes it impossible to obtain the proper i-f response.

If alignment is attempted without first adjusting the traps, only an approximation of the correct response can be attained. Then, when the traps are tuned to their correct respective frequencies, the over-all response still is incorrect, and the whole i-f alignment procedure must be repeated.

This is due to the fact that, with the traps misadjusted at the beginning, each i-f coil must be tuned to some frequency other than the normal one when an attempt is made to overcome the absorption of energy at frequencies close to that to which the mis-adjusted traps are tuned. Merely correcting the trap adjustments does not of itself correct the mis-adjustments of the other i-f circuits caused by attempting to align them when the traps were out of adjustment.

For the signal generator and meter technique, the equipment is connected as pictured in Figure 7 and the receiver power is turned on. The adjustments are made as follows: Set the signal generator for unmodulated r-f output, and to the frequency of the first trap or traps to be tuned. This frequency is given in the alignment instruction chart for each receiver model.

With a non-metallic alignment tool, adjust the movable cores of the specified trap coils to obtain minimum reading on a low direct

voltage range of the vtvm. The r-f output from the signal generator should be no higher than is necessary to give a scale reading of about 3 volts before the traps are adjusted. However, some increase in generator output may be necessary to make final adjustments of the traps.

After completing adjustments of all traps which are to be tuned to the first trap frequency listed in the instructions, the signal generator dial is set to the second trap frequency given, and the indicated trap coil or coils adjusted for minimum reading on the meter scale as before. This same procedure is followed for each of the listed frequencies until all the traps in the i-f section have been tuned.

Next, the signal generator is set to the first i-f test frequency listed, and the specified i-f coil tuned by adjusting its core for maximum deflection of the vtvm pointer. As each adjustment is made, the signal generator output should be reduced to maintain a maximum voltmeter reading of not more than 2 volts. This reduction in test signal input is necessary to prevent overloading the later i-f amplifier stages, because such overloading results in false output indications.

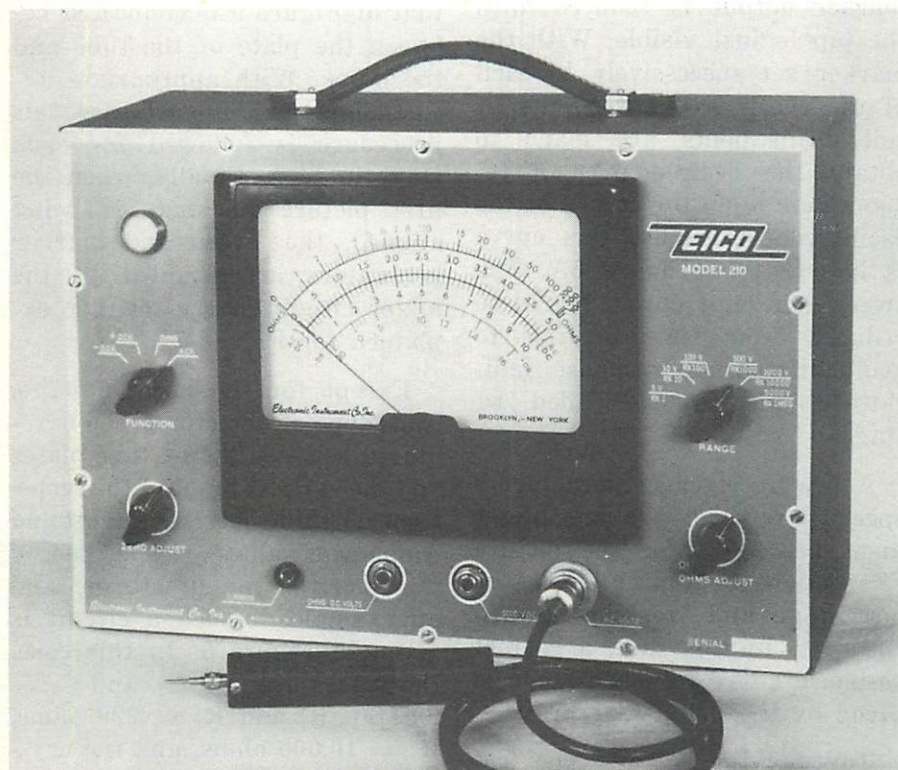
The signal generator again is set to each of the other test frequencies in the order in which

they are listed and the corresponding coils tuned for maximum vtm reading. Each time an i-f coil is tuned, the signal generator output is reduced when necessary to prevent the maximum reading from exceeding 2 volts.

To use the sweep generator and oscilloscope system, the sweep generator is attached to the mixer and the oscilloscope is connected across the video detector load resistor as explained for Figure 7.

The output from the detector is applied to the vertical input terminals of the scope, and the time base output from the sweep generator is applied to the scope horizontal amplifier input.

The scope sweep selector is set to the horizontal amplifier position. The sweep generator is set to the center frequency and to a sweep width of about 10 mc. The scope vertical and horizontal gain controls are adjusted until the pattern almost fills the screen



Useful for television alignment, this vacuum-tube voltmeter has a large, easily read dial, and an r-f probe.

Courtesy Electronic Instrument Co., Inc.

horizontally and about one-half to two-thirds of the screen vertically.

The internal marker generator is turned on, or the external marker generator properly coupled, and set to each of the trap frequencies. With the marker generator adjusted to maximum output, the trap is tuned for minimum marker pip.

After this procedure has been repeated for each trap, the marker output is reduced until the pip is just visible. With the marker set successively to each of the check frequencies, the i-f coil adjustments are made to obtain the desired over-all response curve on the screen of the oscilloscope. Usually, this curve is like that of Figure 5A. The sweep generator output has to be reduced from time to time to avoid inaccurate response indications due to overloaded i-f stages.

A few receiver manufacturers specify a stage-by-stage alignment procedure for the picture i-f section, beginning with the last stage and working toward the first. In this case, a correct response curve for each stage is given by the manufacturer.

To tune the coils of the last stage, the sweep generator output and marker signals are applied to the grid of the last i-f

amplifier tube, and the oscilloscope is connected across the video detector load resistor as in Figure 7. Adjustments of the coil cores are made until the required response is obtained as indicated by the markers at the various check frequencies.

After this stage is aligned, the sweep and marker signals are applied to the grid of the preceding i-f amplifier tube. So that the response is that of the single stage under test, a detector probe like that of Figure 9 is connected between the plate of the tube and the scope. With appropriate adjustments made in each case, this procedure is followed for each stage in turn. Finally, when the first picture i-f stage is being aligned, the sweep and marker generators are coupled to the mixer circuit in the manner explained for Figure 7.

Except for the last i-f stage, some type of detector probe is required between the i-f tube plates and the vertical input of the scope. Generally, the detector circuit and component values are specified by the receiver manufacturer, and an example of such a circuit is given in Figure 9. In this case, the values are: C_1 , C_2 , and $C_3 = .001 \mu\text{f}$, R_1 and $R_3 = 220 \text{ ohms}$, $R_2 = 10,000 \text{ ohms}$, and the crystal rectifier is a type 1N34.

When a stage-by-stage alignment is made, the various traps

are tuned before the i-f coils for each particular stage. However, it is not necessary to tune all the traps in the i-f section before beginning the coupling circuit alignment, as is the case with the alignment system explained in connection with Figure 7.

After a careful alignment procedure has been carried out by either of the above methods, the serviceman often can make improvements by final adjustments with the receiver in operation, while observing a transmitted test pattern. In this way, the limitations in the accuracy of the servicing equipment can be overcome. However, alignment should be nearly completed before this is done. Any attempt to make initial alignment by this method results in a time wasteful process that in no manner assures a good picture.

SOUND I-F ALIGNMENT

For the sound i-f section, the connection points for the alignment equipment are different, depending upon whether the receiver is of the intercarrier or dual channel type. The sound i-f and detector circuits of an intercarrier receiver are shown in Figure 10. Here, the 4.5 mc i-f carrier is amplified by v-f output amplifier V_1 , and coupled through C_1 and L_2 to the grid of first sound i-f amplifier tube V_2 . The FM signal is amplified by the V_2 and V_3

stages, and demodulated by the audio detector V_4 , the a-f signal finally appearing across volume control potentiometer P_1 .

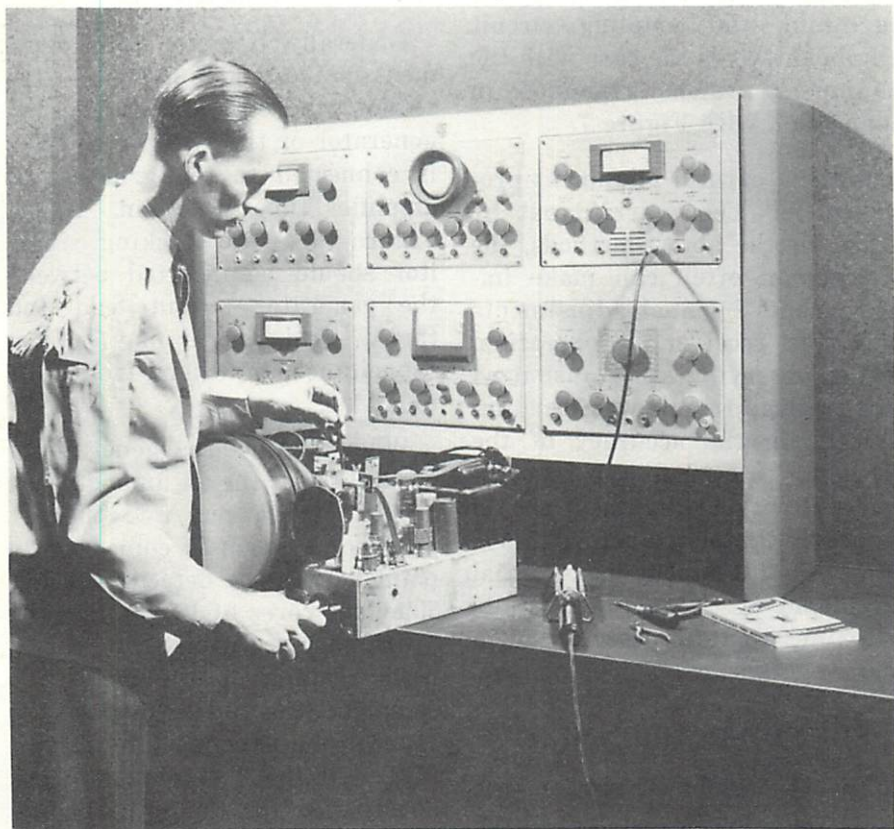
Generally, data for both alignment methods are given for this section, and either the r-f signal generator or the sweep generator is connected to the grid of v-f amplifier tube V_1 , point "A" in Figure 10. A d-c blocking capacitor should be inserted between the generator output lead and the V_1 grid, and it may have a capacitance anywhere from .001 to .01 μ f.

When an AM signal generator is used, it is set for an unmodulated output of 4.5 mc, and the d-c probe of a vtvm is connected to point "C" in the detector circuit. Then the cores of L_2 , T_1 , and the T_2 primary are adjusted for maximum reading on the meter. To complete the adjustments, the vtvm probe is connected to point "D", and the T_2 secondary core is adjusted for the zero reading that occurs between the positive and negative deflections of the meter pointer.

When a sweep generator is used, it is set for a 450 kc sweep with a center frequency of 4.5 mc and connected to point A. Point "C" in the detector circuit is connected to the vertical input of an oscilloscope. One lead of stabilizer capacitor C_8 is disconnected so that a curve like that of Figure

5B is obtained on the scope screen. Core adjustments of L_2 , T_1 , and the T_2 primary are made to pro-

scope vertical input, and a curve like that of either Figure 5C or 5D should be obtained. Adjust-



This built-in test rack contains all the equipment necessary to align any AM or FM radio or television receiver.

Courtesy Radio Corporation of America

duce maximum amplitude and symmetry of the curve.

The center frequency point on the curve is indicated by means of an injected marker signal of 4.5 mc. With C_8 reconnected, point "D" is connected to the

ment of the T_2 secondary core is made until the marker pip appears at the midpoint on the "S" curve of Figure 5C, or at the crossover point of the lines in the pattern of Figure 5D. A slight readjustment of the T_2 primary core may now be made for maxi-

mum length and linearity of the diagonal or cross-over lines.

Extreme accuracy is needed for effective intercarrier sound alignment. Therefore, after initial adjustment is made as described, it is necessary to remove the generator, replace the stabilizer capacitor, tune in a station transmitting a test signal, and adjust the coils for the meter indications described for the signal generator meter method.

For sound i-f section alignment in a dual-channel type receiver, the test point connections are indicated in the simplified diagram of Figure 11. For the alignment of the picture i-f section, the various test signals are applied to the mixer stage by means of the floating shield arrangement at point "A". Here, the accuracy of the equipment is not as critical as for the intercarrier system. However, for good results, the alignment of dual channel sound i-f should be carried out with the same generator used for the picture i-f alignment. Otherwise, the sound and picture for a given channel may come in best at different tuning positions.

When the signal generator system is used, this instrument is set to the sound i-f carrier frequency, and its unmodulated output applied to the receiver mixer, point "A" of Figure 11. The d-c probe

of the vtvm is connected to point "B" in series with a 10,000 ohm resistor, and the cores of the i-f amplifier coupling transformers, including T_2 , adjusted for maximum meter reading. Following this, the voltmeter probe is connected to point "C", and the primary of T_3 adjusted for maximum reading. Finally, with the voltmeter probe at point "D", the secondary of T_3 is adjusted for minimum or zero reading. In the event the sound i-f circuits are only slightly mis-aligned, the voltmeter connection to point "B" may be omitted, and all the adjustments of the first two steps above made with the meter connected to point "C".

When the sweep generator is used, the i-f amplifier coupling circuits are tuned to produce maximum amplitude and symmetry of the curve of Figure 5B, with the oscilloscope connected through a 10,000 ohm resistor to point "B", Figure 11. Then with the scope connected to point "D", the primary and secondary windings of T_3 are adjusted for a pattern like that of Figure 5C or 5D, as explained for the intercarrier type receivers.

4.5 MC TRAP ADJUSTMENT

All intercarrier receivers and some dual-channel types contain an LC circuit tuned to 4.5 mega-

cycles in the output of the video detector or amplifier. This circuit is arranged to prevent the 4.5 mc beat signal from being applied to the picture tube. Because of this function, the circuit is called a 4.5 mc trap.

For intercarrier receivers, adjustment of this trap usually forms part of the sound i-f alignment procedure. However, for some intercarrier receivers and most dual-channel receivers, the 4.5 mc trap is adjusted after the sound i-f section alignment is completed. The r-f signal generator is set to provide a 4.5 mc unmodulated output which is applied to the grid of the first video amplifier stage.

Either of two methods of connecting the vtvm to obtain the output reading may be employed. One consists of connecting the meter d-c probe through a detector circuit like that of Figure 12, to the picture tube grid or cathode, whichever is the signal input element. The ground side of the probe and detector circuit are connected to the receiver chassis. For the circuit of Figure 12, the rectifier may be a type 1N34 crystal, capacitor $C = .05 \mu\text{f}$, $R_1 = 1$ megohm, and $R_2 = 220,000$ ohms.

The second method consists of removing the 1st sound i-f amplifier tube from its socket, and connecting a $50 \mu\text{f}$ capacitor from

the grid (or cathode) of the picture tube to the grid of the 2nd sound i-f amplifier. The vtvm probe is connected to point "C", Figure 10, with C_8 temporarily disconnected, or to point "C", Figure 11. For either method, the trap is tuned for minimum deflection of the meter pointer.

R-F SECTION ALIGNMENT

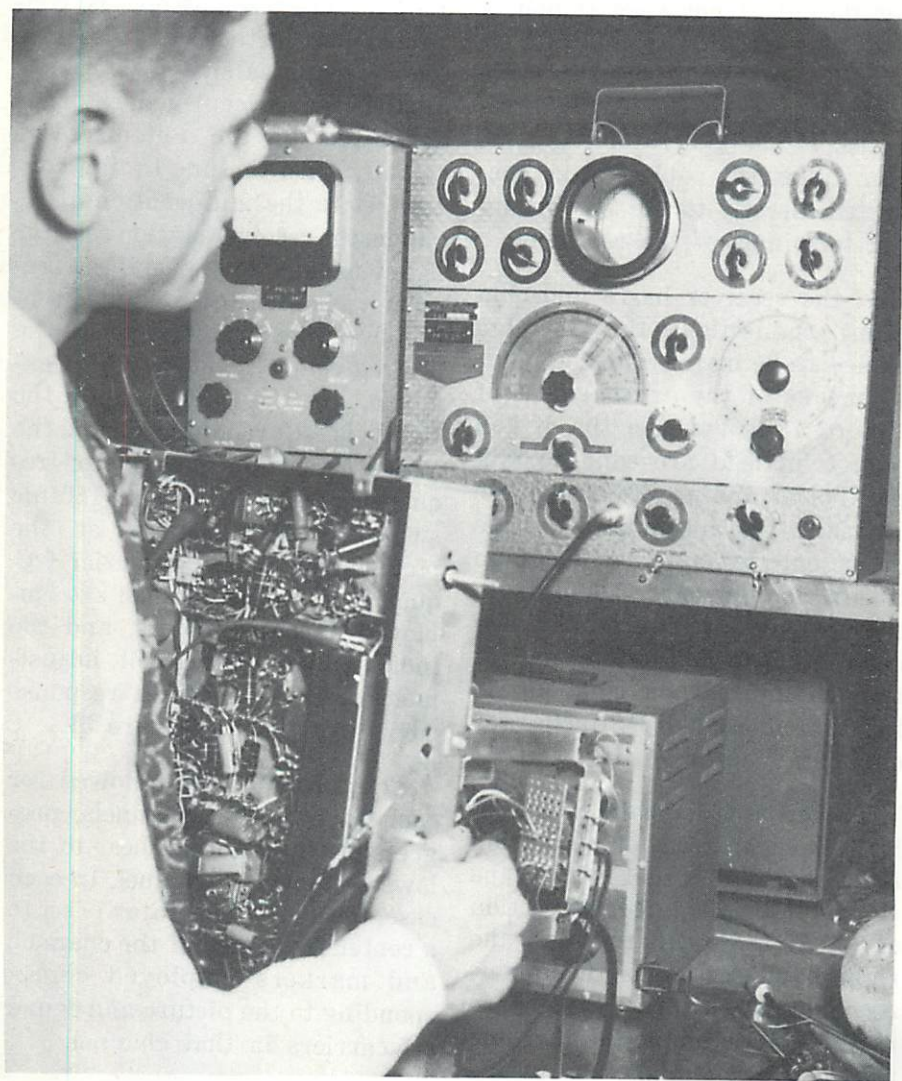
As explained earlier, for alignment of the picture i-f section, the oscillator is disabled by removing the oscillator tube, or by substituting a tube from which the oscillator plate pin is cut. This arrangement is retained during the alignment of the sound i-f section, and the adjustment of the 4.5 mc trap circuit. For alignment of the r-f section, operation of the oscillator stage must be restored by replacing the original oscillator tube in its socket.

Usually, the signal generator or sweep generator has a coaxial type output cable which has a characteristic impedance on the order of 50 or 75 ohms. This cable should be terminated in a resistance equal to its characteristic impedance, and also should be matched to the 300 ohm input impedance of the television receiver.

To satisfy these conditions, a resistor network like that of Figure 13A is used. Here, R_1 is made

equal to the coaxial cable impedance, and R_2 and R_3 are equal to each other and of such value that the total of R_1 , R_2 , and R_3 is ap-

proximately equal to 300 ohms. For example, if $R_1 = 50$ ohms, resistances of 120 ohms each for R_2 and R_3 may be used for a total



The basic instruments required to service a TV receiver are shown on the top shelf. From left to right, they are a vtvm and a combination oscilloscope and signal generator.

Courtesy Philco Corp.

of 290 ohms. All resistors should be of the carbon or composition type, not wire wound.

Since the r-f or sweep generator output is not very strong, a matching circuit like that of Figure 13A cannot be used in some cases because of the loss it introduces. If the generator has a 73 ohm cable, the cable can be connected directly to the 75 ohm input terminals of the receiver.

If the receiver has a 300 ohm input connection, the 73 ohm cable can be matched to the input by means of the arrangement of Figure 13B. Two lengths of 150 ohm twin lead are connected in parallel at one end to match the coaxial cable, and in series at the other end to match a 300 ohm line which, in turn, connects to the receiver input terminals. For channels 2 to 6, the length L of the matching leads is about 39 inches, and about $14\frac{1}{2}$ inches for channels 7 to 13.

The circuit diagram of a typical television receiver r-f section is shown in Figure 14. V_1 is the r-f amplifier, the left hand section of V_2 is the oscillator, and the right hand section is the mixer. As indicated, a turret type channel selector is employed, and fine tuning is accomplished by means of C_9 . For alignment, the test signals are applied to the antenna terminals at point "A".

Oscillator Alignment

To align the oscillator in inter-carrier type receivers, the sweep generator method usually is employed. The oscilloscope is connected across the video detector load resistor as shown in Figure 7 and the sweep generator is connected to the antenna terminals. With the fine tuning control set to the mid-position of its range, the receiver station selector is set usually to the highest frequency channel to be aligned and the sweep generator is set to the desired center frequency. For example, in the VHF band, the switch is set to channel 13, and the sweep generator to a center frequency of 213 mc with a 110 mc sweep. Marker signals at the picture and sound r-f carrier frequencies for this channel are employed as check points, and the indicated oscillator coil adjustment made to obtain a response curve like that of Figure 5E.

This procedure is followed for each of the other channels, progressing from the highest to the lowest numbered channel. In each case, the sweep generator is set to a center frequency of the channel, and markers employed corresponding to the picture and sound r-f carriers in that channel.

Generally, the signal generator and meter method is specified for dual-channel type receivers. In

this case, the d-c probe of the vtvm is connected to the output of the audio detector and the signal generator is connected to the antenna terminals. The receiver fine tuning control is set to its mid-position, and beginning with the highest channel and working down through the lowest, the signal generator output is set to the sound r-f carrier frequencies and the oscillator coil core adjusted for minimum or zero meter reading.

Many receivers contain a trimmer across the oscillator tank circuit. This capacitor provides a means of adjusting the oscillator for all channels at once. Alignment of the individual coil cores may not be necessary, and a preliminary attempt should be made to align the oscillator for all channels by adjusting this trimmer. This may be done with either the intercarrier or dual-channel type receivers.

The all-channel trimmer cannot be used to align individual channels, however, and if its adjustment fails to align the oscillator circuits sufficiently, it is necessary to adjust the channel coil cores by one of the methods previously explained.

R-F Amplifier and Mixer Alignment

Generally, the sweep generator method is specified for alignment

of the r-f amplifier and mixer stages for both dual-channel and intercarrier type receivers. The oscilloscope is connected through a 10,000 ohm resistor to the junction between the two series resistors which connect from the mixer tube grid to ground. This test point is indicated as "B" in Figure 14.

The sweep generator center frequency is set to the mid-frequency for each channel, a 10 mc sweep is employed, and markers used which correspond to the respective channel picture and sound r-f carrier frequencies. Adjustments usually are specified for all channels, although adjustments for only certain channels are specified in some cases. All adjustments are made to obtain a response curve similar to that of Figure 5F.

TOUCH-UP ADJUSTMENTS

Often, complete alignment is undertaken unnecessarily. A careful diagnosis of the trouble sometimes will indicate that a mere touching-up of certain adjustments will accomplish the desired results in a much shorter time. In addition, certain of the more critical adjustments often have to be touched-up slightly even after the above steps have been performed carefully.

Generally, some touch-up of the oscillator circuits and the FM detector secondary coil is needed,

especially when the accuracy of the dial calibration of the r-f signal generator or marker generator is not known. To make touch-up adjustments, it is necessary to restore the receiver to normal operating conditions by replacing any tubes, etc., which were removed for the regular alignment.

For a dual-channel type receiver, the station selector is set to the highest used channel on which a program or test pattern is being transmitted. The fine tuning control is set to the mid-position of its range, and the h-f oscillator coil core is adjusted to obtain good resolution (not brightest picture) as observed on the receiver viewing screen. When good resolution and balance are obtained, the picture carrier is at the 50% point on the receiver response curve.

Leaving the oscillator adjusted in this manner, a vtvm is connected to the FM detector output circuit, point "D" Figure 11. The detector transformer secondary core is adjusted for minimum reading on the voltmeter, thus tuning this circuit to a frequency exactly 4.5 mc below the picture i-f carrier.

The receiver channel selector is set to each of the other used channels in turn, and the corresponding oscillator coil core is adjusted for minimum reading on the

vtvm. This completes the touch-up adjustments. However, as previously pointed out, these adjustments cannot be substituted when complete alignment is necessary.

To touch-up the oscillator alignment in an intercarrier type receiver, it is necessary to adjust each oscillator coil core for proper balance between maximum sound and best picture definition, with the fine tuning control in its mid-range position.

All touch-up adjustments should involve only very slight changes in the existing settings. In the event appreciable changes are needed to produce the desired results, then the over-all response curves should be checked using the sweep generator and oscilloscope.

ALIGNMENT DIFFICULTIES

In the visual alignment method with the sweep generator, various unexpected results often are obtained, such that the patterns produced on the oscilloscope screen are considerably different from the curves specified in the manufacturer's service manual. Similar erratic results are obtained with the signal generator and vtvm method.

For the sake of clarity, mention of these difficulties was omitted from the step-by-step procedures given in the preceding paragraphs. However, the causes

should be understood by the service technician to assure successful alignment of television receivers.

In addition to being modified due to mis-alignment of the receiver tuned circuits, the observed response curves and vtvm readings may contain irregularities because of the nature of the test equipment, or the inability of the technician to operate the equipment properly.

The service technician should read the instruction manual carefully for every piece of test equipment which he uses. These manuals contain extremely informative data prepared for the express purpose of assisting the technician in properly applying his instruments. Experience alone is never an adequate substitute for reading these manuals.

Stray R-F

Often, stray r-f energy is picked up by the leads connecting the signal or sweep generator to the signal insertion point in the receiver. This energy results in regeneration which causes unstable output indications. To prevent noise pickup in this way, both the center conductor and the ground lead from the generator output cable should be made as short as possible. Neither of these leads should protrude more than two inches from the end of

the cable, and may be as short as one inch by omitting the alligator clips.



The central selector switch sets the sweep oscillator to the center frequencies of the indicated channels and thus permits rapid channel changing in the TV sweep generator.

Courtesy RCA Victor Div.,
Radio Corporation of America

Moreover, very short wire jumpers should be used as grounds between each piece of test equipment and the receiver chassis at a point near the circuits being aligned. Whenever connection to the grid of a tube is made, a .001 μ f mica or ceramic blocking capacitor should be included in series with the high lead. In addition, the output cable should be terminated by a $\frac{1}{4}$ or $\frac{1}{2}$ watt resistor equal to the characteristic impedance of the cable, as illustrated in Figure 15.

Oscilloscope Response

The desired picture i-f response curve has been described in con-

nection with Figure 4, and, providing the sweep generator and receiver circuits are operating properly, the voltage wave-form applied to the vertical input of the oscilloscope is as shown in Figure 16A. This wave-form closely approaches that of a low-frequency square wave. If the scope vertical amplifier has inadequate low-frequency response, the applied voltage is distorted by the amplifier so that the wave-form applied to the deflection plates may appear like that of Figure 16B.

As alternate halves of the test voltage cycle are produced on the scope screen during the forward and return trace sweeps of the beam, the resulting pattern produced on the screen will be as shown in Figure 16C. Note that this pattern is due to a fault of the oscilloscope circuit rather than to mis-alignment of the receiver circuits.

If the technician assumes the distortion of Figure 16C to be due to receiver mis-alignment, and tries to secure the proper response curve by adjusting the cores of the various receiver coils, the result will be mis-alignment of the circuits which may have been properly aligned in the first place. An experienced technician may be able to visualize how the trace of Figure 16C would appear if there were no low-fre-

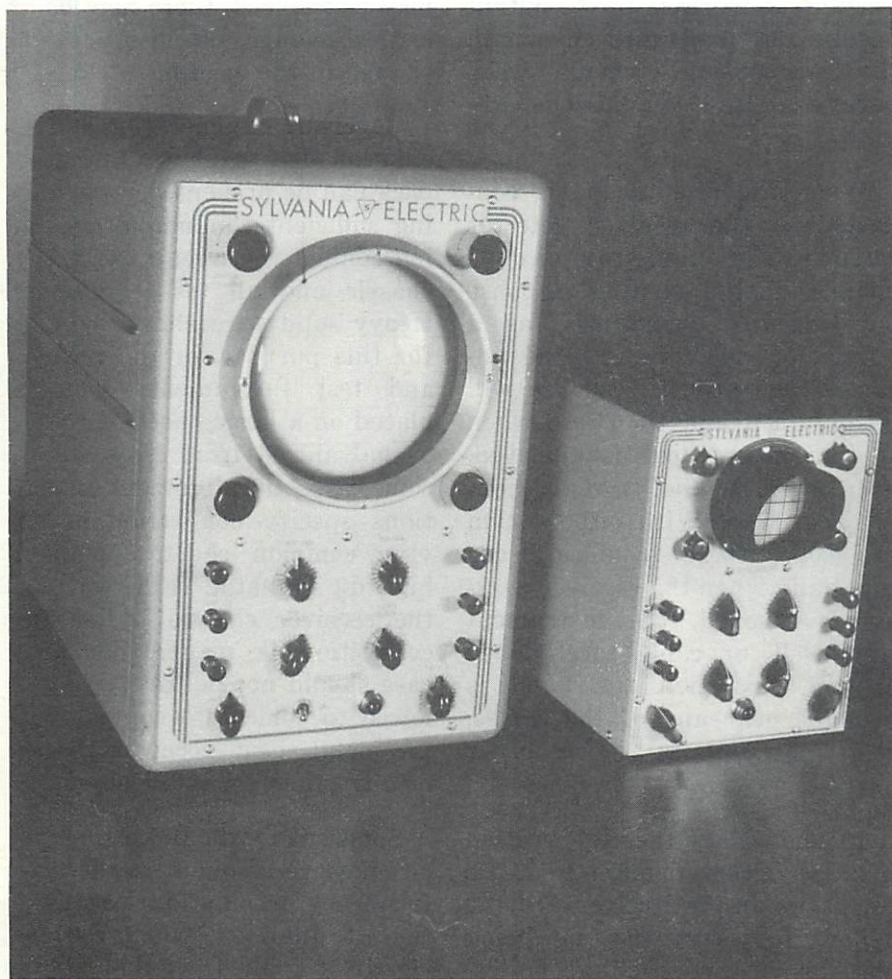
quency distortion in the oscilloscope amplifier, and make alignment adjustments accordingly.

However, this is difficult to do, and a better plan is to improve the low-frequency response of the oscilloscope by replacing the coupling and bypass capacitors in the scope vertical amplifier circuit with units of higher capacitances. The cathode bypass capacitor should be increased to about 500 μ f, or can be omitted entirely, although its omission will result in some loss of gain in the amplifier stage.

Figure 16D shows the normal response curve shape for the receiver sound i-f section, while Figure 16E shows the resulting pattern obtained when the normal voltage wave is applied to a scope having poor low-frequency response. In this case, only the lower portion of the curve is produced with double traces. Knowing the reason for this effect, the technician may ignore these loops and make alignment adjustments to obtain maximum height and symmetry of the upper portion of the curve.

Oscillations

As the receiver and test instruments are all connected to the a-c power line, r-f energy may be coupled from the receiver, vtvm, or oscilloscope by radiation or



Service type oscilloscopes with either small or large screens are suitable for visual alignment work.

Courtesy Sylvania Electric Products, Inc.

through the power line to the test generator or early stages of the receiver. This feed-back causes regeneration and, when a vtvm is connected to the video or audio detector output, the meter reading may remain normal for a few moments, then suddenly build up

to a high reading, though no adjustments were made. This may be followed by a fluctuation and a gradual drop in output.

Another symptom of regeneration is that a very small increase in applied test signal causes a

very great increase in the output reading, or a definite change in the response curve when a sweep generator and oscilloscope are used.

When the oscilloscope is connected to the receiver detector output, regeneration causes changes in the existing response curve shape. Sometimes, as a particular coil core is being adjusted, the proper response will be obtained and then lost when the alignment tool is removed, even when the tool is of the non-metallic type. With either vtvm or scope, these troubles occur especially when the receiver chassis is touched, the instrument test leads or cables are moved around, or when the hand is brought near any of the cables, test instruments, or receiver chassis.

In some cases, the regeneration may be severe enough to cause oscillation in the receiver circuits. When the response is being checked with an oscilloscope, oscillation causes widening of the observed curve in a region corresponding to a band centered about the produced beat frequency, as illustrated in Figure 16F. When a vtvm is used, oscillation results in a reading being obtained at the detector output even though no signal is applied. Then, when a test signal is applied, either the meter reading

may be reduced, there may be an erratic change, or no observable change in the reading.

Generally, regeneration and oscillation due to power line feedback can be prevented by providing sufficient conductive grounding contacts between the receiver chassis and all test equipment. Heavy solid wire should be used for this purpose, or the receiver and test instruments may be placed on a large sheet of copper or galvanized iron. However, in some cases, the alignment instructions specify connection of the vtvm common lead to a point of high d-c potential rather than to the receiver chassis. When this connection is made, the meter case should not be touched or allowed to come into contact with the metal sheet, receiver chassis, or any other grounded object.

Sometimes, when two tuned i-f circuits are resonant to the same frequency, oscillation occurs in the i-f amplifier when the test signal is applied, so that a high voltmeter reading is obtained at the detector output, independent of the amplitude of the applied signal. If the contrast control circuit is designed to vary the bias on the i-f amplifier grids, this oscillation may be stopped by rotating the contrast control to increase the applied negative bias. Another method consists of removing the test signal from

the mixer tube circuit, and applying it through the network of Figure 13A to the receiver input terminals.

Oscillations that occur when the scope or meter is connected to the detector load often can be avoided by connection to the video amplifier grid load resistor. Thus, the high video frequencies that exist across the peaking coils do not reach the oscilloscope or meter. Finally, it may be necessary to ground the grids of the first i-f stages through .001 μ f capacitors, and apply the test signal to the grid of the last i-f tube only.

After this stage is aligned, the shunting capacitor is removed from and the test signal applied to the grid of the preceding stage for its alignment, etc., until the entire i-f section is aligned. If oscillation still exists, it is probably due to some cause other than mis-alignment, and a check should be made of i-f amplifier tubes, operating voltages, bypass capacitors, and coil shunting resistors.

R-F Amplitude

It has been mentioned that the signal generator and sweep generator outputs should be kept low, just enough signal amplitude being employed to provide a satisfactory output from the detec-

tor circuit. Excessive test signal input may cause overloading in the later i-f stages, and produce erroneous output indications.

For example, suppose the receiver actually is out of alignment such that its picture i-f amplifier has the response shown in Figure 16G. If the test signal input is increased sufficiently, the overloaded stages act as limiters to produce a curve like that of Figure 16H. Here, the flattened top gives the false impression that the i-f section over-all frequency response is correct. Also, the technician experiences the impression that alignment adjustments do not affect the top of the response curve.

If the sweep generator output is not flat over the band of swept frequencies, then this inaccuracy should be accounted for when the instrument is employed to align the circuits of a television receiver. In the case of sweep generators of the type in which the output of a single oscillator is frequency-modulated to obtain the sweep output, the generator output can be checked by means of an oscilloscope and a detector circuit like that of Figure 12.

In this case, the R and C values used are: $R_1 = 120,000$ ohms, $R_2 = 220,000$ ohms, $C_1 = 270$ μ f, and the crystal may be a type 1N34. The capacitor lead is con-

nected to the center conductor of the generator cable, and the free lead of R_2 to the vertical input of the scope. The generator center frequency is set to the center of the band to be checked, and the blanking switch turned on.

If the output is constant over the band, two parallel horizontal lines are produced on the scope screen. However, if the generator output changes with frequency, one of the lines will be slanted or curved in one direction or the other, as pictured in Figure 16I. If the generator does not contain a blanking switch, only one line is produced.

Most sweep generators obtain their output by means of beating the output of a fixed-frequency oscillator against that of an FM oscillator. In this case, the output contains several spurious frequency outputs in addition to the desired output, and the detector circuit of Figure 12 cannot be employed to check the generator output in the manner explained above.

About the only practical way that these units can be checked is to apply the test signal to the circuits of a receiver, the response of which is known. Then, any deviation from the known response can be assumed to be due to inaccuracies in the generator output.

Of course, all test lead and grounding connections must be made carefully.

For any type sweep generator, if receiver circuit adjustments are made to produce an observed pattern like that of Figure 16J when, for example, the generator provides an output like that of Figure 16I, the coupling circuits then will have been misaligned to compensate for deficiencies in the sweep generator output. That is, the receiver circuits will be providing less response to frequencies represented by the right side of the curve in the Figure, because the test input is greater in this region. To provide correct alignment in this case, receiver coil adjustments should be made to obtain a curve like that of Figure 16K.

In the various explanations of this lesson, frequent reference has been made to the alignment instructions given in the various manufacturer's service manuals. These instructions are available from a number of sources, in addition to the manufacturers themselves. In the event no such alignment information is available on a particular model, the service technician should be certain of the functions of the various circuits and of the frequencies involved, before making any adjustments.

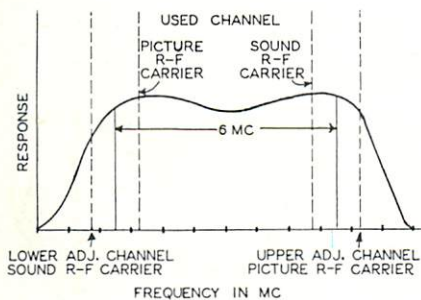


FIGURE 1

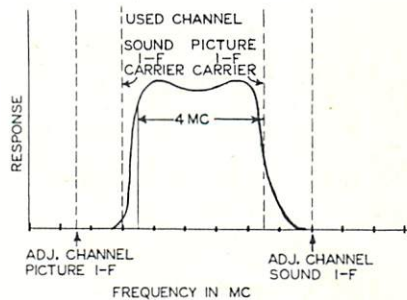


FIGURE 2

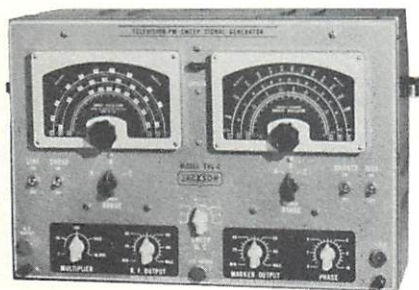


FIGURE 3

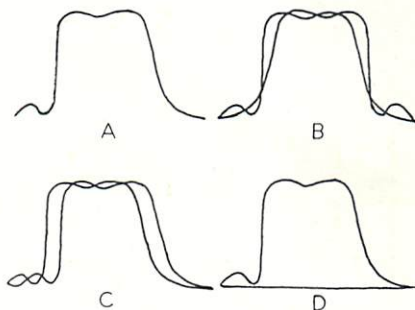


FIGURE 4

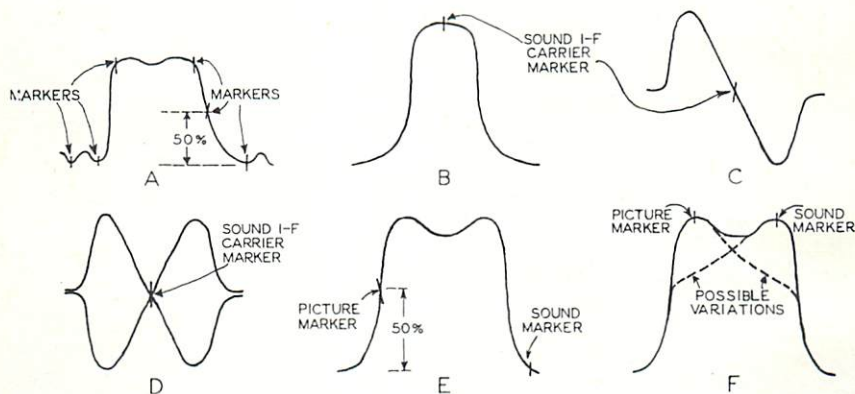


FIGURE 5

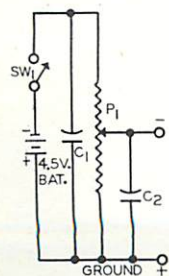


FIGURE 6

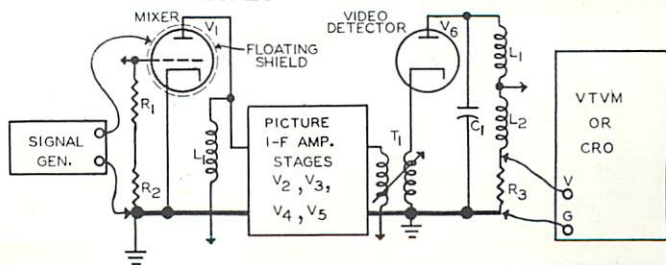


FIGURE 7

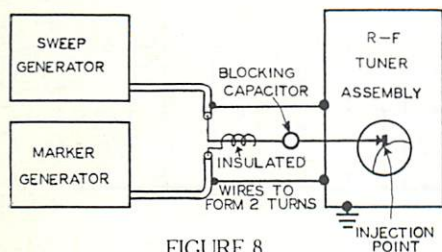


FIGURE 8

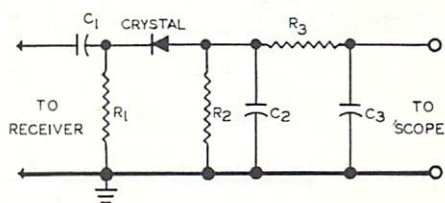


FIGURE 9

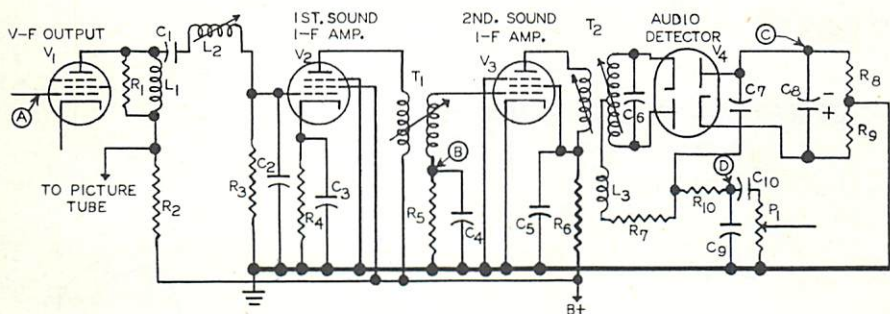


FIGURE 10

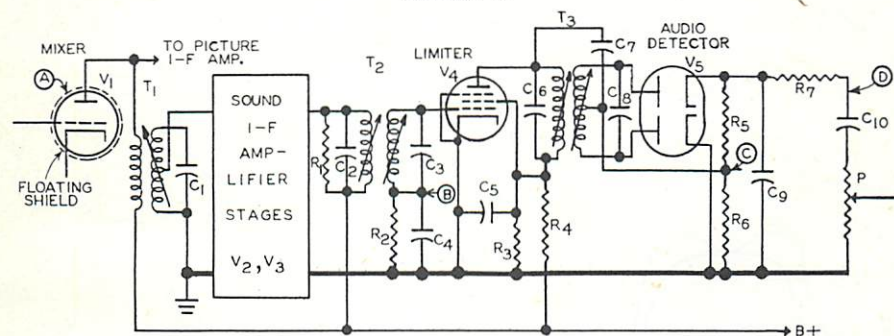
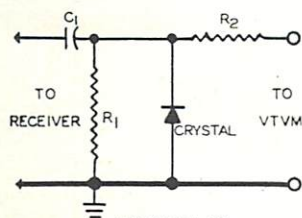


FIGURE 11



T4E-1 FIGURE 12

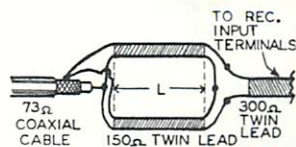
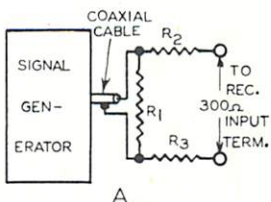


FIGURE 13

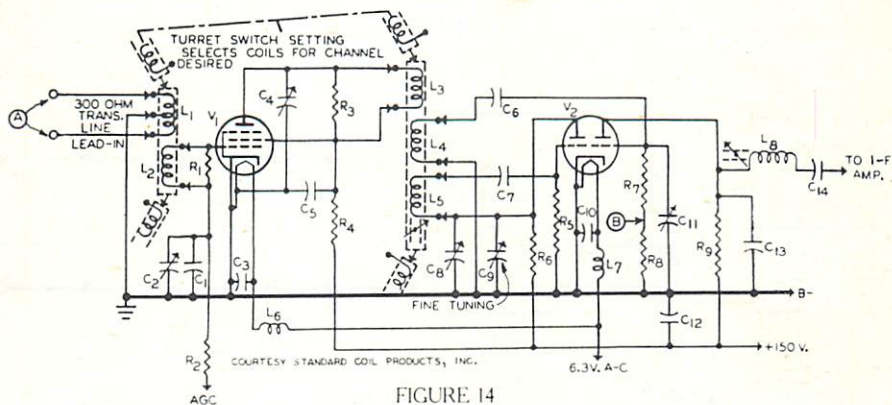


FIGURE 14

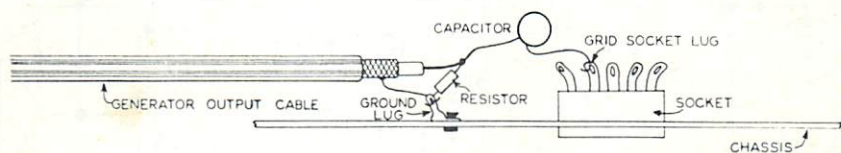


FIGURE 15

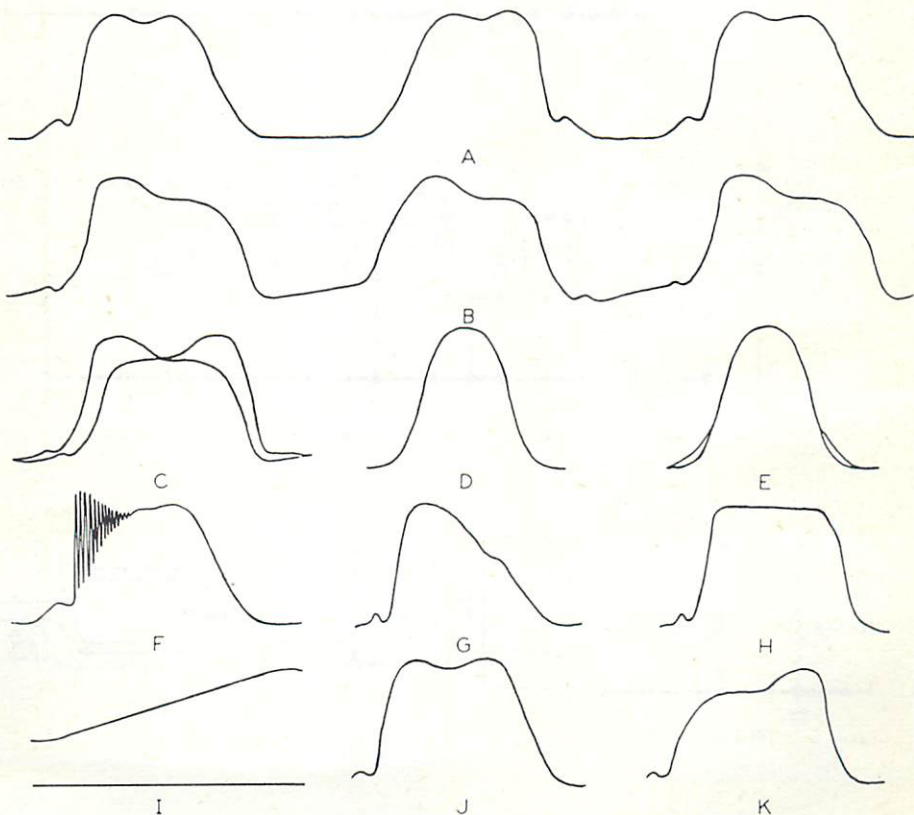


FIGURE 16

FROM OUR *Director's* NOTEBOOK

BORN LUCKY?

An old saying puts it, "Some people are just born lucky. They always have money. They own better things; their friends are more influential. They get more because they have more."

Oh yeah?

Lucky means that a man got up earlier and plugged harder. Lucky means he made things happen by careful planning and had the gumption to push the plans through.

It means he lived on less than he made, that in life's daily struggle he was better informed, wiser, abler, and more persistent than his competitors.

Few people are born lucky. Good luck comes to those who know things and do things and never quit. Luck is the product of a persistent struggle toward the goal you have set.

Apply these principles when you establish your own business and maybe some day they'll say about you, "Oh, he was just born lucky."

Yours for success,

W. C. Alvey
DIRECTOR